

THE OUTLOOK FOR PROCESSING PEANUT MEAL INTO EDIBLE PRODUCTS IN GEORGIA

by
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ENGINEERING EXPERIMENT STATION
Industrial Development Division
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Summary

Georgia leads the nation in volume of peanuts crushed. Meal constitutes 60% of the peanuts crushed, while the remaining 40% goes to oil. Traditionally peanut meal is used for feed or fertilizer purposes, which bring minimal returns. If the meals are processed into vegetable protein products such as flour, concentrate, isolate, or textured items, returns to farmers and processors would increase significantly. Peanut meals were sold at 1 cent to 4 cents per pound as fertilizer or for feed purposes in 1972, while the values of edible vegetable protein products were 10 cents to over 50 cents a pound.

The markets for vegetable protein products are large and growing. These markets will continue to grow because of the relatively low costs of vegetable proteins compared with meat proteins and the adverse publicity concerning saturated fats in meats in recent years. Since the volume of peanuts available for crushing has been increasing over the years and the burden of the price support paid to peanut farmers by the government also has been increasing steadily, it would be advantageous if peanut meal, a by-product in oil crushing, could become a more valuable sales item through further processing. Likely peanut protein products would offer a large market outlet for peanut meal at a higher value. At the same time, the costs of government price support for peanuts would be reduced.

Peanut proteins are similar to soy proteins, according to research reports. In 1970, the markets for soy protein products in the United States were estimated at 500 million pounds to 600 million pounds in the forms of flour and grits, 35 million pounds of concentrates, 25 million pounds of isolates, and 30 million pounds of textured items. Annual growth of these markets was estimated at 10% to 20%. According to projections made by the U. S. Department of Agriculture, the markets for soy proteins would increase to 1,874 million pounds (low level), 3,018 million pounds (medium level), or 3,962 million pounds (high level) by 1980.

Vegetable protein products are used for three general purposes: (1) as a partial or complete substitute for meat in processed items such as patties, chili, casseroles, sausages, etc.; (2) as meat analogs that resemble specific meats in texture, color, and flavor; and (3) as a fortifier or conditioner in

making pancake mixes, waffles, cereals, biscuits, muffins, doughnuts, breads, rolls, cakes and mixes, cookies, snack items, and beverages.

Peanut proteins in the forms of flour, flakes, and grits have been made available in recent months. Other products, such as concentrate, isolate, and textured items, are still under development. Several food companies are regularly using peanut flour or grits as a part of their required material mix. The market potentials for peanut flour and grits currently are estimated at 265 million pounds a year.

Three processes for manufacturing peanut proteins are in different stages of development. One was developed by the Engineering Experiment Station at the Georgia Institute of Technology. Peanut meals, restricted or unrestricted, can be processed into protein isolate with 94% protein content. Based on a 1,820-ton pilot plant, annual output would be 2,382,000 pounds of protein isolate, 528 tons of feed (with 23% protein content), and 58,800 pounds of peanut oil. Investment requirements for such a plant would be \$511,000 in fixed capital and \$121,000 in working capital. Net income after taxes was estimated at 26% of fixed investment in a normal year.

The second process is being developed by the Food Protein Research and Development Center, Texas A & M University. Whole peanuts are used as raw material. Output from the process would consist 38.6% of protein concentrate (67% protein content), 40.4% of crude oil, 7.2% of whey solids, and 13.8% of process loss. The production costs would amount to 17 cents per pound of protein concentrate produced. Investment requirements for a model plant are currently under investigation.

A third process is under development by the Southern Regional Research Laboratory. Edible-grade CCC oil stock is used. Output would comprise crude peanut oil, 45%; protein concentrate (with 68% to 70% protein content), 24%; flour with skin (with 48% protein content), 28%; and process loss, 3%. Fixed investment was estimated between \$1.5 million and \$2 million for a 100-ton-per-day capacity.

A simple flour milling unit can be set up in a peanut crushing plant. A cooling-conveying system and a milling system would be required. The cost of such an installation would be \$16,000, excluding auxiliary equipment.

It is proposed that research be conducted in 10 areas relating to peanut protein products. They include seed improvement, process procedure, equipment design, new uses for the products, product quality, markets and marketing practices, production economics, transportation analysis, consumer response, and government regulations.

INTRODUCTION

This research work is an outgrowth of a contract research project concerning peanut processing opportunities in southwest Georgia completed in 1972.^{1/} Through the research work done previously, it was learned that peanut meal presents an opportunity for further processing, especially in Georgia. The growing volume of peanuts available for crushing, the low value of peanut meal relative to processed protein products, and a recent government statement concerning peanut meal for edible purposes also influenced the decision to undertake this research project on peanut meal.

The report is intended to be concise for two reasons. The major reason was the scarcity of information because the development of protein products through processing peanut meal is still in a beginning stage. The depth of the study also was limited by the amount of funds available for the project.

The general purpose of this research work was to make an initial exploration of peanut meals for edible purposes in order to find out the potentials of this by-product from peanut oil crushing. Specific objectives of the project are given below:

- (1) To explore potential end uses and markets for peanut proteins at the present and in the future.
- (2) To investigate available processing methods for peanut protein products.
- (3) To examine future research and development needs.

The information obtained for this study came largely from personal interviews with knowledgeable persons in the industry and various publications concerning vegetable proteins. Notes from private files also were used extensively.

^{1/} E. E. Brown, T. I. Chiang, D. S. Clifton, and others, Peanut Processing Opportunities, a joint publication of the Coastal Plains Regional Commission, Southwest Georgia Planning and Development Commission, Rural Development Center, Georgia Institute of Technology, and University of Georgia, June 1972.

WHY CONSIDER PROCESSING PEANUT MEAL FOR EDIBLE PROTEIN PRODUCTS IN GEORGIA?

In 1971, the Southeast accounted for 53.4% of the nation's peanut acreage and 61.6% of the nation's production. In the same year, Georgia alone produced 42.4% of the nation's output or about 1,269,900,000 pounds in farmer stock. Of Georgia's production, 48.8% or 619,895,000 pounds went to crushing for oil and meal.

Crushed peanuts yield about 60% meal and 40% oil. Peanut oil receives a premium price over other kinds of vegetable oils in the marketplace. Traditionally peanut meal is used for animal and poultry feeds or for fertilizer. Both uses bring nominal returns to farmers and processing concerns. On September 17, 1971, the Agricultural Stabilization and Conservation Service in Washington, D. C., made the following statement:

On the basis of an opinion furnished us by the Office of the General Counsel, we have verified that there is no legal objection to the use for domestic edible purposes of wholesome meal produced from peanuts sold by CCC under Amendment OC-10 for the restricted uses of domestic crushing or export.

The statement has cleared the way for the development of edible proteins based on peanut meal, although it has been known for a long time that peanut meal is a high-protein-content material which can be processed into edible foods. In the past year several private and public agencies have engaged in research and development efforts to make peanut proteins available for edible purposes. It is believed that peanut protein production may become an important enterprise some day, for the following reasons:

1. Trends toward the use of vegetable proteins because of unsaturated fats and low costs. Meats are high in saturated fats, which are contributory factors in hardening of the arteries and other coronary diseases. About 38% of all adult deaths in this country are the result of coronary disease. The adverse publicity concerning saturated fats in recent years has caused people to use more vegetable proteins in the place of meats, with a clear trend in this direction readily apparent. The sharp rise in meat prices in recent months and the outlook for improved vegetable-protein technology will expedite the replacement of meats by vegetable protein products.

Vegetable proteins are much lower in cost than are animal proteins. A much larger land space is required to generate a given amount of protein in

meat form than in vegetable form. Vegetable protein products long have been a major source of nutrition for human consumption abroad, and they are becoming increasingly important in this nation.

2. Expanding markets for vegetable proteins. The market for soy protein alone was estimated to be around 500 million pounds to 600 million pounds a year in the United States in 1970. Vegetable proteins originating from peanuts, sunflower seed, and cottonseed are being developed to meet the world protein crisis. World malnutrition problems are seen more and more as protein problems. As the protein technology concerning taste, appearance, and nutrition improves, the market potentials of vegetable proteins will continue to increase. Expanded markets would lead to lower production costs, which in turn would improve the market potentials. The market for vegetable proteins has been projected by authoritative sources to increase by 10% to 20% a year in the United States in the next decade.

3. Increasing peanut volume available for crushing. Although the U. S. peanut acreage allotment total remains constant at the legal minimum of 1.6 million acres annually, the volume of peanuts produced has increased steadily due to gains made in per-acre yields. Average yield per acre more than doubled from 1950 to 1972, rising from 1,061 pounds to a record 2,209 pounds. In the same period, the annual production of peanuts increased from 1,523 million pounds to 3,287 million pounds on a farmer's stock basis. The Southeast's share of the national production increased from about 50% to roughly 60% at the present level. Total peanut production in the United States is projected to reach 4.1 billion pounds in 1980 and 4.7 billion pounds by 1985 (nearly 45% more than 1972),^{1/} barring a sudden change in the government price support policy on peanuts or any unforeseen crisis which might develop at home or abroad.

About two-thirds of the total consumption of peanuts is in edible products (chiefly peanut butter, candy, salted nuts, and nuts roasted in the shell) and related items. However, the consumption of peanuts as food has increased less than has production volume. As a consequence, surplus peanuts must be diverted either to crushing for oil and meal or to the export market. Since the peanut price in the world market is considerably lower than the domestic support price,

^{1/} George W. Kromer, "U. S. Peanut Economy in the 1980's," Fats and Oils, FOS-265, U. S. Department of Agriculture, November 1972.

about 90% of the surplus peanuts must be crushed for oil and meal. Projections indicate that about half of the peanut crop in the 1980's will be crushed.

4. The need to reduce government costs in the peanut price support program. Peanuts are under the government price support program. When peanut farmers are not able to sell their stocks through commercial outlets, CCC absorbs the surplus stock at 75% of current parity prices. The peanut parity price has increased rather steadily -- from 12.9 cents per pound in 1959 to 19.0 cents in 1972 -- and it is projected to reach 32 cents by 1985. Although the government paid 19 cents per pound to farmers under the price support program in 1972, it sold its stock to crushing plants for only 8 cents a pound, at a loss of 11 cents a pound plus handling and storage costs.

In 1972, peanut meal was sold at 4 cents per pound for feed and at only 1 cent per pound for fertilizer purposes. If peanut meal were processed into flour, protein concentrate, and protein isolate, the respective values of these processed items would be 8 cents, 18 cents, and 35 cents per pound. Thus, the higher value of processed products would increase the sales value of CCC peanuts. As a result, costs to the government of maintaining the peanut support price would be reduced.

THE MARKET POTENTIALS OF EDIBLE PEANUT PROTEIN PRODUCTS

Peanut Proteins and Soy Proteins

The characteristics of peanut proteins are similar to those of soy proteins, according to research reports. However, soy proteins have an established status in the market and a lead time in years, if not in decades, in the areas of research, product development, marketing channels, and institutional organization. The interest in developing peanut meal for edible protein use is only a recent event, and initial efforts to promote edible peanut proteins in the marketplace have been made only in the last few months by the Georgia Peanut Commission and by Gold Kist, Inc. Any attempt to foresee the market potentials of peanut proteins for edible purposes is premature at this time. However, the size and outlook of the soy proteins market may provide an indication of what peanut protein producers may expect to attain. Very likely peanut protein producers would have to follow in the footsteps of soy protein producers and share the market with them in this juvenile stage.

Soy proteins are generally classified into four basic groups: (1) flour, flakes, and grits; (2) concentrates; (3) isolates; and (4) spun and textured protein products. All come from clean, dehulled soybeans, but differ in protein content, physical and chemical properties, food application, and price. Peanut proteins are commercially available only in the forms of flour, flakes, and grits at the present time. Although protein concentrates, isolates, or textured products can be made from peanut meal or flour, they are still in the research and development stage. Nevertheless, flour and grits are the most widely used vegetable-based proteins in the market today.

A comparison of the basic compositions of peanut flour and soy flour is interesting. Two known trade names were selected for this purpose. One is "Soyafluff," which is produced by Central Soya, a leading soy products producer in the world; the other is "Gold Nut Flour," produced by Gold Kist, Inc., the only peanut protein producer in the nation at the present. The products are derived from either soy meal or peanut meal. The compositions of both products are quite similar in terms of protein, fat, fiber, ash, carbohydrates, and moisture, as shown in Table 1.

Prices of soy flour and peanut flour are reported to be similar. However, peanut flour is sold at a slightly lower price in the Southeast than soy flour,

Table 1
ANALYSIS OF PEANUT FLOUR AND SOY FLOUR

<u>Composition</u>	<u>Gold Nut Flour^{a/}</u> <u>(in percent)</u>	<u>Soyafluff-200 T^{b/}</u> <u>(in percent)</u>
Protein	57.0	53.0
Fat	0.6	1.0
Fiber	4.6	2.5
Ash	4.6	6.0
Carbohydrates	30.0	31.0
Moisture	<u>3.2</u>	<u>6.5</u>
Total	100.0	100.0

Sources: a/ Gold Kist, Inc., Atlanta, Georgia.

b/ Central Soya, Chemurgy Division, Chicago, Illinois.

due to a shorter hauling distance and lower transportation costs. In 1972, peanut flour was sold at 8 cents per pound in the South while soy flour was sold at 9 1/2 cents per pound, according to trade sources.

Although both peanut flour and soy flour contain slightly over 50% protein, their protein contents differ to some extent. Amino acids are the basic elements of proteins and also the basic elements for nutrition. The types and relative proportions of essential amino acids in any protein determine its biological quality or nutritive value. The probable nutritional value of protein proposed for human feeding can be estimated by comparison of its amino acid profile with known human essential amino acid requirements. Table 2 indicates the essential amino acid contents of peanut, soybean, and skim milk proteins relative to that of an adequate pattern for maintenance and growth as indicated by the FAO (1957) Reference Protein. As indicated in the table, the nutritive quality of peanut protein is limited primarily by its content of lysine and methionine, and it is marginal in tryptophan and threonine. On the other hand, soy protein is deficient only in methionine. However, the deficiency in some amino acids is probably of limited practical significance because vegetable proteins are largely used in conjunction with protein from animal sources, thereby assuring a satisfactory amino acid balance. In the competition for a share of the future protein market, other factors such as price, taste,

Table 2
COMPARISON OF ESSENTIAL AMINO ACID LEVELS IN FAO
REFERENCE PROTEIN AND PROTEINS OF PEANUT, SOYBEAN, AND SKIM MILK
(in percent of protein)

<u>Essential Amino Acid</u>	<u>FAO Reference</u>	<u>Peanut</u>	<u>Soybean</u>	<u>Skim Milk</u>
Lysine	4.2	3.0	6.8	8.6
Tryptophan	1.4	1.0	1.4	1.5
Phenylalanine	2.8	5.1	5.3	5.5
Methionine	2.2	1.0	1.7	3.2
Threonine	2.8	2.6	3.9	4.7
Leucine	4.8	6.7	8.0	11.0
Isoleucine	4.2	4.6	6.0	7.5
Valine	4.2	4.4	5.3	7.0

Source: Max Milner, "Peanuts as a Protein Resource in International Feeding Programs," Food Technology 16(7):46, 1962.

appearance, variety of supply, and market promotion may prove to be more decisive elements than the contents of amino acids.

According to trade sources, peanut flour has a better flavor than soy flour, which has a beany taste. Flavor of any food item is an important marketing factor. One should remember that a protein source is not necessarily a food unless it has desirable qualities which tempt a person to eat it. From a nutritional standpoint, peanut flour is an excellent product. It has about ten times the mineral content of wheat flour, five times as much protein, and is much richer in vitamins. Peanuts are high in calcium and iron compared with most other food products. Since calcium and iron are two of the minerals most likely to be lacking in the diet, their presence in relatively large amounts adds to their value as food. In addition, peanut flour can be made snow-white in color, which is important in certain end uses for foods, while soy flour stays tan or gray.

End Uses and Market Potentials

In recent years, the technology of fabricating foods from vegetable proteins has been so improved that the substitutes for meats are commanding

attention, as has been stated previously. Adverse publicity over the use of animal fat in the diet also has been an important factor in the rapidly expanding market for vegetable proteins. The low cost of vegetable proteins relative to animal proteins provides an additional incentive for their use by people both here and abroad.

Vegetable protein is prepared for three general purposes: (1) as a partial or complete substitute for meat in processed items such as patties, chili, casseroles, sausages, hot dogs, etc.; (2) as meat analogs that resemble specific meats in texture, color, and flavor; and (3) as a fortifier or conditioner in making pancake mixes, waffles, cereals, biscuits, muffins, doughnuts, breads, rolls, cakes and mixes, cookies, snack items, and beverages.

Soy protein products are the dominant vegetable protein in the market today. Of the four major types, flour, flakes, and grits are simplest in form, and they contain about 50% protein. They are the screened, graded products obtained after expelling or extracting most of the oil from selected sound, clean, dehulled soybeans. Flour is a finely ground product, flakes are flat and unground, and grits are coarsely ground. Grits and flakes can be substituted for flour in many situations, depending on the desired texture.

Soy protein concentrates comprise about 60% to 70% protein on a moisture-free basis, while isolates contain 90% to 97% protein. Because of lower yields and higher costs in producing concentrates and isolates, they command higher prices than flour, flakes, and grits. Spun and textured products are simulated meat items or analogs for such items as chicken, turkey, ham, beef, frankfurters, or even nutmeats and fruit bits. These simulated products are high in protein content, with no waste in bone, fat, and skin, and come in a variety of colors and flavors. They have caused much of the recent excitement in the trade. Because of labeling regulations, standards of identity, and public tastes, meat analogs have been slow in expanding their share of the market.

The estimated soy protein production in the United States in 1970 is given in Table 3. Flour and grits were estimated at 500 to 600 million pounds, concentrates at 35 million pounds, isolates at 25 million pounds, and textured items at about 30 million pounds. According to a trade source, these markets have been growing at 10% to 20% a year.

The protein content, price range, estimated 1970 production, and current uses of these soy protein products are given in Table 3. As indicated in the

Table 3

ESTIMATED U. S. PRODUCTION OF SOY PROTEIN FOODS, 1970

<u>Soy Protein Food</u>	<u>Protein Content (in percent)</u>	<u>Price (in cents per pound)</u>	<u>Estimated 1970 Production (in millions of pounds)</u>	<u>Current Uses</u>
Flour and grits ^{1/}	40 - 55	5½ - 11½	500 - 600	Ingredients for baked goods, dog foods, sausages
Concentrates	60 - 70	18 - 25	35	Manufacturing textured products; ingredient in processed meats, baby foods, health foods
Isolates	90 - 97	35 - 45	25	Manufacturing analogs, for use in comminuted meats, such as meat loaf, frankfurters, etc.
Textured items ^{2/}				
Extruded	50 - 55	28 and up	30	Simulated bacon strips and bits, pork, beef, chicken, fish, ham, and similar foods
Spun	90+	50 and up		

^{1/} Flour and grits, although handled differently and sold for different uses, are essentially the same product. Both are ground defatted flakes. Grits are coarse (larger than 100 mesh); flour is fine ground (smaller than 100 mesh).

^{2/} Textured items are of two distinctly different types. Extruded items, made from flour, are textured by high-temperature, high-pressure extrusion, using a plastic type extruder. Spun items, made from isolates, are spun, using somewhat the same technique used in rayon or nylon.

Source: U. S. Department of Agriculture, Economic Research Service, Synthetics and Substitutes for Agricultural Products, Projections for 1980, Marketing Research Report No. 947, March 1972.

table, flour and grits were sold at 5.5 cents to 11.5 cents per pound in 1970. They were used as ingredients for baked goods, dog foods, sausages, and the like. Soy protein concentrates were sold at 18 cents to 25 cents per pound and were used for manufacturing textured products or as an ingredient in processed meats, baby foods, and health foods. Soy protein isolates were sold at 35 cents to 45 cents per pound and were used as basic material for manufacturing analogs, for use in comminuted meats such as meat loaf, frankfurters, and similar products. There are two kinds of textured items -- extruded and spun. Extruded products were sold at 28 cents and up per pound, while spun items were sold for 50 cents and up per pound. They are used as simulated meats, such as bacon, pork, beef, chicken, fish, ham, and similar foods.

Based on three levels of growth -- low, medium, and high -- projected soy protein production in 1980 is presented in Table 4. These three levels of production are broken down by the different kinds of meat replaced, based on the present food regulations and technology. The low level of meat replaced (or soy protein substituted for meat) is estimated at 1,874 million pounds by 1980. Based on the estimated soy proteins production of 600 million pounds in 1970, the output is projected to triple in a 10-year period. The medium level is projected at 3,018 million pounds and the high level is estimated at 3,962 million pounds by 1980. These levels represent production of five to six times the 1970 volume. The details in pounds of meat replaced, kind, and percent replaced are given in the table. These projections were based on soy protein substitution for meats only, not counting substitutes for non-meat foods.

According to Dr. Herbert Stone, director of Stanford Research Institute's food sciences department, consumption of protein concentrates in the United States will increase from about 500 million pounds in 1970 to 5 billion pounds by 1985. A few years ago, he says, high-protein meat substitutes made from low-cost plant sources retained an aftertaste of the original plant flavor, but now their taste and texture can be made indistinguishable from that of meat. By the 1980's many Americans will be eating ersatz "ham" made from soy protein, boneless "chicken" from cottonseed protein, and "hamburgers" from peanut protein.^{1/}

^{1/} Herbert Stone, "Meat Substitutes from Plant Sources," Chemical and Engineering News, April 24, 1972.

Table 4

PROJECTED IMPACT OF SOY PROTEIN SUBSTITUTION IN POUNDS OF MEAT,
KIND, AND ESTIMATED PERCENT OF MEAT REPLACED IN THE UNITED STATES, 1980

<u>Impact of Low Level</u>	Meat Replaced ^{a/} (in millions of pounds)	Percent of Estimated 1980 Meat Production
Cattle and calves	1,166	4.00
Hogs	602	4.00
Sheep and lambs	18	4.00
Chickens and turkeys	<u>88</u>	2.36
Total	1,874	
<u>Impact of Medium Level</u>		
Cattle and calves	1,892	6.50
Hogs	977	6.50
Sheep and lambs	29	6.50
Chickens and turkeys	<u>120</u>	3.22
Total	3,018	
<u>Impact of High Level</u>		
Cattle and calves	2,471	8.50
Hogs	1,275	8.40
Sheep and lambs	38	8.50
Chickens and turkeys	<u>178</u>	4.77
Total	3,962	

a/ Soy protein substituted for meat.

Source: U. S. Department of Agriculture, Economic Research Service, Synthetics and Substitutes for Agricultural Products, Projections for 1980, Report No. 947, March 1972.

A recent article concerning soy protein products as meat substitutes, published in The Wall Street Journal, stated that the sales of "Juicy Burger," which consists of 75% ground beef and 25% soy protein, plus a few flavorings, are very strong in certain cities. Customers were not even realizing that the composition was different. The sales of soy protein products for human consumption, according to the National Soybean Processors Association, totaled about \$75 million in 1972, a tenfold jump from five years earlier. Sales in

1973, buoyed by the growth of the soy ground beef extenders, are expected to reach \$120 million to \$140 million, and a market of some \$2 billion is forecasted for a decade hence.^{1/}

This vast and growing market for vegetable proteins is not for soybeans alone. Peanuts, cottonseeds, and sunflower seeds could share the booming market if adequate research and development work were done. With a better flavor and lighter color than soy proteins, peanut proteins should not have great difficulty in finding acceptance when they come out of the laboratories and are introduced in the market.

Current Sales of Peanut Protein Products

As indicated previously, peanut protein is a rather new item in the market and it is available only in the forms of flour, flakes, and grits. Several companies are actually using peanut flour as a part of their required materials in making barbecue sauce, steak sauce, beef patties, chili sauce, and beverages. A number of nationally known companies are taking steps to explore the use of peanut flour and grits as a part of their end-product mix. The potential market for peanut flour among these companies has been estimated at 265 million pounds annually. The entire output of peanut meal in the Southeast would have to be processed into flour in order to meet this demand. Further information on current uses and potential demands may be obtained from the Georgia Agricultural Commodity Commission for Peanuts in Tifton, Georgia.

^{1/} Norman H. Fischer, "Beanburgers -- More Americans Turn to Soybean Products as Meat Substitutes," The Wall Street Journal, April 3, 1973, p. 1.

PROCESSING PEANUT PROTEIN PRODUCTS

Source Materials and Sanitary Requirements

Generally two sources of raw materials can be used for the production of peanut protein products -- whole peanuts and meal, which is the leftover material after extracting oil from peanuts.

In contrast to the practices for the production of feed-grade meal, more attention should be paid to peanut selection for the manufacture of food-grade flour, grits, concentrates, and isolates. Important quality factors include grade, removal of foreign matter of field origin, and controlled storage to prevent deterioration and infestation by microorganisms, insects, and rodents. The contamination of oilseeds and presscakes or meals by mycotoxins is a serious problem which has received much attention. Methods should be developed to avoid the contamination.

Attention also should be given to sanitary plant design and to sanitation control in providing wholesome raw material for the production of flour, grits, concentrates, and isolates. Properly processed vegetable protein products are free of pathogenic organisms and possess low standard plate counts, usually less than 50,000 organisms per gram.

In processing peanut flour or grits, sanitary conditions in compliance with Section 402A of the Federal Food, Drug and Cosmetic Act would be required. Details as to acceptable peanut grades, methods of handling, and quality control are available from authoritative sources, such as the Atlanta Regional Office of the U. S. Food and Drug Administration.

Production Processes

The commercial production of peanut protein has just begun in recent months. Processing methods for more advanced products are still in various research and development stages. Three processes are known to date. One was developed by the Engineering Experiment Station at the Georgia Institute of Technology, another by the Food Protein Research and Development Center of Texas A & M University, and the third by the Southern Regional Research Laboratory of the U. S. Department of Agriculture. A brief summary of each process follows.

1. Process Developed by the Engineering Experiment Station, Georgia Institute of Technology.^{1/}

The objective of the research project was to determine, via pilot plant operation, the economics of the Engineering Experiment Station process for protein, as applied to peanut meal and presscake. The project was sponsored by the Georgia Agricultural Commodity Commission for Peanuts and it was completed in December 1972.

The extraction of peanut protein isolate can be made from restricted and unrestricted meal, and from both expeller and solvent mills. A designed plant would operate with a 500-pound batch of meal through each 15 minutes. Each batch would require approximately 90 minutes for completion. Peanut meal input would be seven tons per day and 151.7 tons per month, on the average, allowing necessary time for start-up and close-down of each operation. The yields as a percent of input would average roughly as follows:

Protein isolate (94% protein content)	65%
Animal feed (23% protein content)	29%
Peanut oil	2%
Process loss	<u>4%</u>
Total	100%

Based on an input of 1,820 tons of peanut meal a year, output would be 2,382,000 pounds of protein isolate at 35 cents per pound, 528 tons of animal feed material at \$44 per ton, and 58,800 pounds of peanut oil at 17 cents a pound. Annual gross sales would amount to \$867,000. Production costs were estimated at \$340,000, sales expenses at \$125,000, overhead at \$92,000, and depreciation at \$37,000. Net income after taxes was estimated at \$134,000 or about 26% of fixed investment.

Fixed capital investment for such a plant would total about \$511,000, and working capital would be \$121,000. Fixed investment would include a plant building of 10,600 square feet, one acre of land, and machinery and auxiliary equipment.

Two distinctive advantages of the Engineering Experiment Station process are (1) the elimination of aqueous discharge through utilization and/or

^{1/} W. H. Burrows, Cost Analysis of the Extraction of Protein from Peanut Meal and Presscake, Engineering Experiment Station, Georgia Institute of Technology, December 1972.

recycling, and (2) the use of meal, a residue of peanut oil extracting, as raw material. A patent for the developed process is under application.

2. Process Developed by the Food Protein Research and Development Center, Texas A & M University.

A group of scientists in the Food Protein Research and Development Center, Texas A & M University, is engaged in developing a process for pilot plant-scale production of peanut protein concentrate.^{1/} The technical aspect of the project has been completed; however, economic analysis of production costs, investment requirements, and potential returns has not yet resulted in definite conclusions. Some information obtained concerning the process is given below:

Raw material used: whole (or split) peanuts

Output as percent of input

Protein concentrate (67% protein content)	38.6%
Crude oil	40.4%
Other products (whey solids)	7.2%
Process loss	<u>13.8%</u>
Total	100.0%

The investment requirements for a model plant are currently under investigation. However, based on a given rough estimate, the production cost would be 17 cents per pound of concentrate or 23 cents per pound of pure protein. This estimation is based on the following data:

Price of raw material	8.5¢ per pound shelled oil stock
Price of crude oil	14¢ per pound
Efficiencies of protein and oil recovery	85% each
Processing cost	10¢ per pound of concentrate

The processing cost does include building, equipment, interest, labor, maintenance, administration, and miscellaneous expenses, but does not include the expenses for packaging, marketing, or profit.

3. Process Developed by the Southern Regional Research Laboratory.

In 1967 the Southern Regional Research Laboratory (SRRL) of the U. S. Department of Agriculture developed a process for extracting oil and proteins from cottonseed. The process is called "Acetone-Hexane-Water Extraction of

^{1/} Khee Choon Rhee, Carl M. Cater, and Karl F. Mattil, "Aqueous Process for Pilot Plant-Scale Production of Peanut Protein Concentrate," Journal of Food Science, Vol. 38, 1973.

Cottonseed." Personnel of SRRL plan to modify the process so that it can work on peanuts. It is understood that a pilot plant study with cost analysis and investment requirements may be completed in the next year or so.

The purpose of the adapted process is to make a direct solvent extraction of peanuts to produce oil and meal of high quality, followed by air classification of meal to yield approximately equal weights of protein concentrate and peanut flour with skin. The input-output ratio of the process is estimated as follows:

Input:	Edible CCC oil stock peanuts	100%
Output:	Crude peanut oil	45%
	Protein concentrate (68% to 70% protein content)	24%
	Peanut flour with skin (48% protein content)	28%
	Process loss	3%

Peanut protein concentrate made under this process is a very fine white powder which would lend itself well for food preparation. Peanut flour with skin is a reddish flour which can be used either for feed purposes or as a conditioner for foods where color is not important.

Cost estimates for this process would be premature at this time. However, some rough estimates based on collected information can be made. Processing costs for oil and proteins produced were estimated at \$30 per ton of peanuts processed. Total production costs should be the processing costs plus the cost of peanuts. CCC oil stock (shelled peanuts) was sold for 12.5 cents per pound in April 1973 compared with 8 cents per pound two months previously. The feasibility of processing peanut proteins based on this process depends to a large extent on the price variations of raw materials and finished products. Based on a current cost estimate and three levels of returns, some illustrations are given below:

Production costs per ton of shelled peanuts processed

CCC oil stock at 12.5 cents per pound	\$250
Processing costs	<u>30</u>
Total production cost per ton	\$280

Three levels of returns per ton of peanuts processed

(a) High estimate

Crude oil - 900 pounds at 19 cents per pound	\$171.00
Concentrate - 470 pounds at 25 cents per pound	117.50
Flour - 570 pounds at 8 cents per pound	<u>45.60</u>
Total returns	\$334.10

(b) Medium estimate

Crude oil - 900 pounds at 18 cents per pound	\$162.00
Concentrate - 470 pounds at 20 cents per pound	94.00
Flour - 570 pounds at 6 cents per pound	<u>34.20</u>
Total returns	\$290.20

(c) Low estimate

Crude oil - 900 pounds at 17 cents per pound	\$153.00
Concentrate - 470 pounds at 18 cents per pound	84.60
Flour - 570 pounds at 4 cents per pound	<u>22.80</u>
Total returns	\$260.40

The prices of the finished products vary daily. Precise cost data cannot be determined until the process itself is completed. It is reported that a plant capable of processing 100 tons per day of peanuts into peanut oil, protein concentrate, and flour would cost about \$1.5 million to \$2 million. To build a 50-ton-per-day plant would cost nearly as much.

For technical information concerning the three processes mentioned, the reader should write: (1) Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia 30332; (2) Food Protein Research and Development Center, Texas A & M University, College Station, Texas 77848; and (3) Southern Regional Research Laboratory, 1100 Robert E. Lee Boulevard, New Orleans, Louisiana 70124.

A Milling Unit within a Peanut Crushing Plant

A simple flour processing unit can be set up within an existing peanut crushing plant with minimum capital outlay. Two major machinery requirements are a meal cooling-conveying system and a milling system.

The cooling-conveying system should adopt a vacuum suction operation to remove the moisture content of meal and to convey screw-pressed or solvent-extracted meal for grinding purposes. The system eliminates corrosion of screw conveyors and permits moisture adjustment before storage. The temperature of meal can be cooled down from 220°F to approximately 10° to 15°F. The meal would be sucked over so that the moisture and temperature can be flushed off in the air. Costs of such a system depend on volume handled per hour, distance conveyed, and elevation of the holding bin at a flour mill. Six to seven thousand dollars is a rough estimate.

A grinding or milling system for 100-mesh peanut flour, including a milling unit with 25-HP drive motor, a screener model, and a suction conveyor, would cost about \$10,000.

Auxiliary equipment, such as storage bins, packing and filling machinery, and quality control instruments, has not been included in the above estimates.

RESEARCH AND DEVELOPMENT NEEDS

Vegetable protein products have a large and growing market. Since production and marketing of peanut protein products are only just beginning, various research and development efforts are needed to assure them a definite share of this growing market. Ten research areas are proposed here, but they are not exclusive. Research areas listed range from breeding new peanut species to a study of government regulations. They are as follows:

(1) Breed new peanut species especially for the production of peanut protein products such as flour, concentrates, and isolates. Newly developed species should have a high protein content.

(2) Design process procedure in the production of peanut protein products in order to satisfy the following areas:

- (a) Raw material selection
- (b) Control of processing conditions, particularly time-temperature relationship
- (c) Sanitary requirements safeguards
- (d) Methods of product quality control
- (e) Analysis of factors affecting product qualities such as protein quality, solubility over pH ranges 2.5-8.0, ash content, carbohydrate content, and possible toxic matters

(3) Develop new or improved equipment for drying, conditioning, handling, storing, and preparing for market to improve the quality of peanut protein products and reduce marketing costs.

(4) Develop new uses for flour, grits, concentrates, and isolates for food purposes.

(5) Study potential uses of peanut flour for industrial purposes, such as sizing and adhesive materials.

(6) Develop packaging and transportation methods and techniques to maintain product quality and reduce transportation costs.

(7) Evaluate the overall structure and performance of vegetable protein markets, including studies of prices, marketing costs, margins, competition, market information, and marketing practices and services.

(8) Determine relationship of plant size, composition of products, and marketing and processing costs in the production of peanut protein products.

(9) Evaluate consumer response to new products, packages, and methods of handling.

(10) Study government regulations which affect the manufacture and marketing of peanut protein products. Study the government price support program on peanuts, which affects the future supply of peanuts in the United States.

Some of the proposed research programs are long-range ventures and some of them are short-range in nature. A joint effort of private and public agencies would be required to carry out the needed research with the participation of agriculturalists, economists, and engineers.

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